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STUDIES IN DUCK NUTRITION

BY

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3. THE FEEDING OF POTATOES TO DUCKS*

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BECAUSE of the large surpluses of potatoes which occur on Long Island and other areas from time to time and the high cost of duck feed, it was considered desirable to determine the value of potatoes in duck rations. Special attention was given to the use of dried potatoes or potato meal.

Numerous reports deal with the feeding of potatoes to chickens. However, the information on duck feeding is limited. Wright and Dudley (1944, 1945) reported on feeding potatoes to ducks in England during World War II when the regular feeds were limited and when it was necessary to use large amounts of home grown feeds. Their experiments indicated that the body weight, health and general appearance of the birds were satisfactory when semi-dried town waste and steamed potatoes were fed to female ducklings from 2 weeks to laying, the potatoes being introduced gradually and eventually replacing half of the mash by 9 weeks. Rearing on these feeds had no significant effect on egg production or on final body weight.

In order to determine the feeding value of potatoes in the diets of ducks a preliminary experiment was conducted at the Cornell University Agricultural Experiment Station at Ithaca, N. Y. and a larger field experiment on a duck farm in Suffolk County, Long Island, N. Y. Except for supplemental feeding of cooked potatoes, pellets were fed in all experiments since Heuser and Scott (1951) showed that this method of feeding was most desirable.

PRELIMINARY TRIAL

In the preliminary trial conducted at Cornell 15 White Pekin ducks per lot were kept on wire floors and fed rations similar to those used in the main experiment. The starting ration was fed for the first four weeks and the grower ration for the next five weeks. Dehydrated potato meal was used in this experiment. The results are shown in Table 1.

At the time of the two-week weighing a considerable number of the ducks showed leg trouble which involved the hock joint. This appeared to be similar to the hock trouble reported in turkeys and also resulted in bowed legs. A very large proportion of the birds in lots 1 to 9 were affected

* Project under Section 10(a) of the Research and Marketing Act of 1946, the Bureaus of Animal Industry and Agricultural and Industrial Chemistry of the Agricultural Research Administration, United States Department of Agriculture, and the Cornell University Agricultural Experiment Station cooperating.

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TABLE 1.—*Weight at 9 weeks and feed consumption of ducks in preliminary trial*

Ration	Weight at 9 weeks	Feed per duck
	lbs.	lbs.
1.—Control—no potato meal	6.11	20.0
2.—20% potato meal replacing 20% corn meal	6.20	20.9
3.—20% potato meal replacing 20% standard middlings	5.98	19.4
4.—20% potato meal replacing 10% corn meal + 10% standard middlings	6.21	20.8
5.—10% potato meal replacing 10% corn meal	6.17	19.8
6.—10% potato meal replacing 10% standard middlings	6.31	20.9
7.—30% potato meal replacing 15% corn meal + 15% standard middlings	6.39	21.2
8.—Control+cooked potatoes equivalent to 20% potato meal*	6.11	19.3
9.—Control+cooked potatoes equivalent to 10% potato meal**	6.42	20.8
10.—Commercial duck ration	6.11	21.2

* Potatoes fed only during second week.
** Potatoes not fed during third, fourth and part of fifth week.

at some time. This condition did not occur in lot 10. The condition was not corrected by feeding additional cod liver oil. Approximately one-fifth of the birds were removed but the rest recovered and were marketable at the end of the experiment.

The plan of the experiment also called for the feeding of natural potatoes. These were boiled and crushed before feeding. However, the feeding was not begun until the second week. It was discontinued when the leg trouble appeared, but resumed again in lot 9 the fifth week. The consumption per bird was as follows:

2nd week	.517 lbs.
5th week (4 days)	2.538
6th week	3.019
7th week	3.667
8th week	3.700
9th week (6 days)	2.400
	15.841

The amount of cooked potatoes consumed would be equivalent to about 15 percent of potato meal in the mash.

From the preliminary trial it can be concluded that 30 percent of the dehydrated potato meal could be used in place of 15 percent corn meal and 15 percent of standard middlings. Cooked potatoes can also be used. On the basis of this experiment it is estimated that 20 lbs. of potatoes per duck could be fed during the first 9 weeks. This would mean an equivalent saving on mash of about 4 pounds and would represent about 20 percent of potato meal in the mash.

MAIN EXPERIMENT

It was thought desirable to conduct a test with large numbers under practical conditions. Through the Suffolk County Extension Service arrangements were made with Mr. Howard Phillips of the C. R. Duck Ranch, Westhampton, Long Island, New York for such facilities. The experiment was conducted for 9 weeks (May 24th to July 27th, 1949).

Experimental Pens. Ten lots beginning with 200 White Pekin ducklings per lot were kept under the following conditions.

1–4 days of age. ¼ sq. ft. of floor space per bird; hover temperature 92°F (decreased 3°F. each day to 80°F. on the fourth day), room temperature 80°F. on the first day; 2 sq. ft. of feeding space and 3 sq. ft. of drinking space per hundred birds.

4–14 days of age. Approximately ¾ sq. ft. of pen space per duck; room temperature 75°F., 6 sq. ft. of feeding space and 4 sq. ft. of drinking space per hundred birds.

14–21 days of age. Approximately 2 sq. ft. of pen space per duck; no heat (minimum temperature was 60°F.) 10 sq. ft. of feeding space and 8 sq. ft. of drinking space per hundred birds.

21–63 days of age. 2 sq. ft. of housing space per duck (ducks were not confined to house during this period), 6 sq. ft. of open pen space with an additional 3 sq. ft. of fresh water creek space per duck for swimming and drinking; 10 sq. ft. of feeding space per 200 ducks; no water within 150 ft. of feed.

Feeding Plan. The rations were fed according to the following outline:

Lot	*Ration No.*
1. Regular ration	1
2. Potato meal (dehydrated) replacing 20% of corn meal	2
3. Potato meal (dehydrated) replacing 20% of standard middlings	3
4. Potato meal (dehydrated) replacing 10% of corn meal+10% of standard middlings	4
5. Potato meal (air-strip dried) replacing 20% of corn meal	5
6. Potato meal (air-strip dried) replacing 20% of standard middlings	6
7. Potato meal (dehydrated) replacing 15% of corn meal+15% of standard middlings	7
8. Potato meal (air-strip dried) replacing 15% of corn meal+15% of standard middlings	8
9. Cooked potatoes fed to furnish the equivalent of 20% potato meal in conjunction with regular rations	1
10. Commercial ration.	

Potato Meals. The dehydrated potato meal was prepared at the Bureau of Agricultural and Industrial Chemistry's Eastern Regional Laboratory. This was done by one of the cheapest known methods consisting of drying the raw ground potatoes in a steam tube dryer (Edwards *et al.*, 1948). The process consists of mashing the potatoes, grinding them in a hammer mill having a $\frac{1}{4}$-inch screen and drying them in a rotary steam tube dryer. The raw ground potatoes cannot be fed directly to the dryer as they would stick on the tubes. It is, therefore, necessary to recycle a portion of the dried product mixing it continuously with the raw ground potatoes so that the moisture content does not exceed 45 percent. Under these conditions sticking is avoided. The dried product is of a dark brown color and granular consistency. After grinding in a hammer mill to pass a 10-mesh screen it is in a form suitable for use as feed. Based on large pilot-plant operations it has been estimated that a factory costing approximately $80,000 could produce about 17 tons of product per 24-hour day at a cost of slightly above $24 per ton. This figure includes all costs except that of the potato and sales expense on the product. A typical analysis of the dried potatoes is as follows:

Moisture	8.65	percent
Crude Protein (N×6.25)	8.86	"
Crude Fat	0.57	"
Crude Fiber	1.42	"
Ash	3.93	"
Carbohydrates (by difference)	75.57	"
	100.00	"

(Additional information on the cost and details of drying potatoes for feed by this and other methods can be obtained from the Eastern Regional Research Laboratory, Philadelphia 18, Pennsylvania.)

The air-strip dried potato meal was produced by sun drying. A section of the concrete runway of the Westhampton, Long Island, airport was used. The potatoes were chopped into small chunks in an ensilage cutter and loaded onto a manure spreader. The chopped potatoes were then spread thinly over the concrete slab at a rate of 100 lbs. of potatoes per 60 sq. ft. After about 36 hours of drying the chunks of potatoes assumed a hard brittle consistency, turned black in color and were found to contain about 12 percent moisture. The temperature of the slab within 6 inches was found to be as high

TABLE 2.—*Duck starter rations fed during the first 3 weeks*

Ingredients	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Potato meal (dehydrated)	—	20.0	20.0	20.0	—	—	30.0	—
Potato meal (air-strip dried)	—	—	—	—	20.0	20.0	—	30.0
Yellow corn meal	23.75	3.75	23.75	13.75	3.75	23.75	8.75	8.75
Standard middlings	30.0	30.0	10.0	20.0	30.0	10.0	15.0	15.0
Red dog flour	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Pulverized heavy oats	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Fish meal (60% protein)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Dried skimmilk	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Dried corn distillers solubles	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Dehyd. alfalfa meal (20% protein)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Steamed bone meal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ground limestone	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Fish liver oil (2000A-400D)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Iodized salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

Manganese sulphate—1 lb. per ton in all rations.

as 120°F. in the direct sunlight, thus contributing to the rapid drying. Apparently rainfall has little effect on the drying process, provided hot sunny days follow the wetting. However, rain may cause a loss of dry matter from the finished product. The dried potatoes were then pushed into piles with a tractor and scraper and loaded with a tractor loader in bulk into trucks or bagged and hauled into storage. The dried potatoes were found to store very well. The chunks were ground just previous to mixing the rations.

Rations. As previously indicated the rations were fed in pellet form except for the supplemental feeding of cooked potatoes. The starter ration, made into pellets of 9/64-inch diameter, was fed during the first three weeks after which time the grower ration, made into pellets of 13/64-inch diameter, was fed. The formulae for the starter rations are given in Table 2 and for the grower rations in Table 3.

RESULTS

The average weekly live weights are shown in Table 4 and a general summary of growth in Table 5. The ducks in pen 9

TABLE 3.—*Duck growing rations fed after the third week*

Ingredients	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Potato meal (dehydrated)	—	20.0	20.0	20.0	—	—	30.0	—
Potato meal (air-strip dried)	—	—	—	—	20.0	20.0	—	30.0
Yellow corn meal	29.75	9.75	29.75	19.75	9.75	29.75	14.75	14.75
Standard middlings	25.0	25.0	5.0	15.0	25.0	5.0	10.0	10.0
Red dog flour	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Pulverized heavy oats	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Fish meal (60% protein)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Dried skimmilk	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Corn gluten meal	4.0	4.0	4.0	4.0	4.0	4.0	5.0	4.0
Dried corn distillers solubles	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Dehyd. alfalfa meal (20% protein)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Steamed bone meal	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Ground limestone	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Iodized salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Activated animal sterol	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Manganese sulphate—1 lb. per ton in all rations.
B-Y 21 feed—4 oz. per ton in all rations.

TABLE 4.—*Average weekly live weight of ducks (pounds)*

Lot	Start	Weeks								
		1	2	3	4	5	6*	7	8	9
1	.135	.316	1.07	1.70	2.60	3.50	4.60	5.41	6.25	6.84
2	.131	.363	1.09	1.70	2.46	3.40	4.33	5.44	5.96	6.59
3	.133	.306	.97	1.37	2.32	3.16	4.21	5.33	6.09	6.66
4	.131	.340	1.05	1.68	2.43	3.70	4.71	5.44	6.41	6.72
5	.135	.355	1.03	1.66	2.69	3.44	4.68	5.46	6.36	6.91
6	.134	.335	.98	1.74	2.70	3.23	4.49	5.18	6.14	6.62
7	.134	.358	1.05	1.74	2.51	2.99	4.10	5.08	5.73	6.34
8	.129	.336	.95	1.56	2.54	3.13	4.24	5.25	5.97	6.57
9	.130	.328	1.01	1.66	2.58	3.37	4.49	5.44	6.24	6.41
10	.133	.310	.90	1.58	2.44	3.24	4.38	4.98	5.51	6.30
Ave.	.133	.334	1.01	1.64	2.53	3.32	4.42	5.31	6.08	6.62

* Weighed one day later on account of heat.

consumed very little of the cooked potatoes when pellets were also fed. If pellets were not available small amounts would be consumed. Because of this the feeding of cooked potatoes was discontinued. Therefore, the results for this pen can be considered as an additional control pen.

A small number of ducks with bowed legs were noticed in pens 1 through 9 during the third week. However, the condition did not develop and apparently did not influence the final results.

The growth of the ducks was very satisfactory on all the experimental rations as compared with the commercial ration. Substituting 20 percent of potato meal for 20 percent of corn meal or 20 percent of standard middlings or a combination of corn and standard middlings, had no effect. There was some indication that a 30 percent substitution was probably the upper limit as feeding this quantity slightly, but not significantly, reduced the weight.

In general the dressed weights of the ducks are in accord with their live weights. The average weight for all the ducks marketed was 6.02 pounds (Table 6).

The cumulative feed consumption for the various lots is shown in Table 7. The average for the whole experiment was 23.06 pounds of feed per duck for the 9 week period.

The amount of feed required to pro-

TABLE 5.—*Summary of influence of potato meal substitutions upon 9 week live weight of ducks (pounds)*

Amount of potato meal in ration	Ingredient Replaced	Kind of potato meal		Ave. wt. for each group	Ave. wt. of all lots
		Dehydrated	Air-strip dried		
None	—	—	—	6.84 6.51	6.68
20%	Corn meal	6.59	6.91	6.75	6.70
	St. middlings	6.66	6.62	6.64	
	½ corn meal ½ st. middlings	6.72	—	6.72	
30%	½ corn meal ½ st. middlings	6.43	6.57	6.50	6.50

TABLE 6.—*Summary of influence of potato meal substitutions upon 9 week dressed weight of ducks (pounds)*

Amount of potato meal in ration	Ingredient replaced	Kind of potato meal		Ave. for each group	Ave. of all lots
		Dehydrated	Air-strip dried		
None	—	—	—	6.19 6.03	6.11
20%	Corn meal St. middlings ½ corn meal ½ st. middlings	5.96 5.93 6.04	6.21 6.11 —	6.09 6.02 6.04	6.05
30%	½ corn meal ½ st. middlings	5.97	5.95	5.96	5.96

duce a pound of duck is given in Table 8. The ducks on the control ration required 3.48 pounds of feed to produce a pound of duck. When 20 percent of potato meal was included in the ration the value was 3.48; when 30 percent of potato meal was included the value was 3.47. It also took 3.47 pounds of the commercial ration to produce a pound of duck.

The losses were extremely low. At the end of the experiment 1,964 ducks remained out of the original 2,000. Most of the losses were due to crippling on account of the leg trouble which made it necessary to cull the birds. Fifteen of the ducks weighed under 4 pounds and were unmarketable.

SUMMARY

There was no effect upon the live weight or the dressed weight of White Pekin ducks at 9 weeks of age when 20 percent of potato meal was substituted for 20 percent of corn meal, 20% of wheat standard middlings, or 10 percent of corn meal plus 10 percent of wheat standard middlings. Thirty percent of potato meal is probably the maximum amount that could be fed under these conditions since there is some indication in one trial that when 30 percent of potato meal replaced 15 percent of corn meal plus 15 percent of wheat standard middlings, the weight was slightly reduced.

There seemed to be no difference be-

TABLE 7.—*Cumulative feed consumption (pounds)*

Lot	Weeks								
	1	2	3	4	5	6	7	8	9
1	.25	1.08	3.10	5.55	8.64	11.67	14.94	18.59	23.25
2	.29	1.26	3.30	5.86	9.07	12.26	15.61	19.21	23.48
3	.28	1.07	2.92	5.25	8.07	11.30	15.04	18.74	22.66
4	.28	1.21	3.07	5.60	8.92	11.75	14.82	18.83	23.05
5	.29	1.23	3.20	6.13	9.16	12.86	16.24	20.39	25.17
6	.28	1.11	3.13	5.98	8.56	11.67	14.48	18.00	22.32
7	.29	1.26	3.24	5.70	8.46	11.55	14.69	18.35	22.75
8	.29	1.21	3.36	5.90	8.40	11.62	15.01	18.66	22.98
9	.24	1.14	3.50	6.04	8.50	12.07	15.03	18.77	23.09
10	.23	1.08	2.87	5.19	7.66	10.70	13.69	17.33	21.88
Ave.	.28	1.17	3.17	5.72	8.54	11.75	14.96	18.69	23.06

TABLE 8.—*Pounds of feed to produce a pound of duck at different ages*

Lot	Weeks					
	4	5	6	7	8	9
1	2.13	2.47	2.54	2.76	2.97	3.40
2	2.38	2.67	2.83	2.87	3.22	3.56
3	2.26	2.55	2.68	2.82	3.08	3.40
4	2.30	2.42	2.50	2.73	2.94	3.43
5	2.28	2.66	2.75	2.98	3.21	3.64
6	2.22	2.65	2.60	2.80	2.93	3.37
7	2.23	2.83	2.82	2.89	3.20	3.44
8	2.32	2.65	2.74	2.86	3.13	3.50
9	2.34	2.52	2.69	2.76	3.01	3.55
10	2.13	2.36	2.44	2.75	3.15	3.47
Ave.	2.26	2.57	2.66	2.82	3.07	3.48

tween the dehydrated potato meal and the air-strip dried potato meal.

The average live weight for all of the ducks in the main experiment at 9 weeks was 6.62 pounds. The average dressed weight was 6.02 pounds.

The average feed consumption per duck for nine weeks in the main experiment was 23.06 pounds or 3.48 pounds of feed per pound of live duck.

Out of 2,000 ducklings started in the main experiment 1,964 were alive at the end of 9 weeks with 1,949 of these marketable. Most of the loss was due to leg trouble which caused crippling.

REFERENCES

Edwards, P. W., C. S. Redfield, A. Hoersch, Jr. and R. K. Eskew. 1948. Producing feed and flour from white potatoes with steam tube driers. U.S.D.A. Bur. Agr. and Ind. Chem. AIC-209 (Eastern Regional Research Laboratory).

Heuser, G. F., and M. L. Scott. 1951. Studies in duck nutrition. I. Methods of feeding. Poultry Sci. 30: 161–163.

Wright, M. M., and F. J. Dudley, 1944. Rearing ducklings on town food waste and steamed potatoes. Harper Adams Utility Poultry J. 29: 35–37.

Wright, M. M., and F. J. Dudley. 1945. Semi-dried town food waste and steamed potatoes for laying ducks reared on these foods. Harper Adams Utility Poultry J. 30: 19–21.